DRAWINGS ATTACHED

913,386

Date of Application and filing Complete Specification Sept. 16, 1960.

No. 31910/60.

Application made in Sweden (No. 8689) on Sept. 18, 1959.

Complete Specification Published Dec. 19, 1962.

Index at acceptance: —Class 39(3), H2D1B.

International Classification: —H05b.

COMPLETE SPECIFICATION

Corona Protection Screen for Inductor Coils of Vacuum Furnaces

We, ALLMANNA SVENSKA ELECTRISKA AKTIEBOLAGET, a Swedish Company, of Vasteras, Sweden, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

In vacuum furnaces in which the heating is brought about by means of an inductor coil, it is extremely difficult to prevent flashover between the coil and surrounding parts of the furnace. The reason that particular problems regarding the occurrence of flashover are present in vacuum furnaces is that the rarefied atmosphere has poor electrical insulation properties, and therefore corona, i.e. electrical gas discharges which can develop into flashover, easily arises.

So that corona shall not arise on the parts under voltage, either on the furnace coil or on the connection leads in the vacuum chamber, these parts are usually electrically insulated and provided around the insulation of the coil conductor with a corona protection screen which may, according to known techniques, consist of a number of conducting layers displaced with respect to one another in the longitudinal direction of the conductor and insulated from each other within the coil so that the electrical voltage induced in it through the field of the coil is divided. Out side the coil the layers are connected with each other and usually also with earth or with another potential under the critical voltage at which corona appears.

If a rupture occurs in the connection between the layers or between a layer and earth potential or other potential under the critical voltage at which corona appears, for example because of mechanical damage or thermal strain, the layer receives approximately the same potential as that part of the copper conductor which the screen encloses. If a rupture arises within a layer, in a similar manner, that part of the layer which after the rupture is not in connection with the other layers or with earth or another potential under the corona limit voltage, receives approximately the same potential as the copper conductors situated within this part. Such apertures result immediately in flashover phenomena so that the furnace can become unusable and the processes which the furnace is intended to carry out must be uncontrollably cut off. Apart from the necessity of re-insulating the furnace coils and possibly replacing or repairing other damaged parts, sometimes the material which is being processed in the furnace may have to be discarded, with the considerable economic losses which this entails.

The present invention relates to an inductor coil having a corona protection screen in which flashover phenomena do not arise as a direct result of a connection between any of its parts, or between these parts and earth potential or another potential under the critical corona limit voltage, ceasing to exist. The invention also includes a process for applying a corona protection screen to the insulation of the conductor of an inductor coil of a vacuum furnace.

According to one feature of the invention a vacuum furnace inductor coil comprises an electrical conductor, a coating of electrical insulation applied around said conductor, a corona protection screen applied on said insulation and comprising electrically conducting or semi-conducting layers displaced with respect to one another in the longitudinal direction of the conductor and insulated from each other, and a tight and pore-free covering of an electrically insulating material enclosing said electrically conducting or semiconducting layers. Preferably the tight and pore-free covering consists of a wrapping of silicone rubber.

It is advantageous if this material has re-

sistance against corona. The conducting or semi-conducting layers are suitably attached to the insulation of the coil with a thermosetting resin. The expression "thermosetting resin" is intended to include not only resins which cure by heating but also resins which cure at room temperature, among others, completely polymerisable resins capable of curing at room temperature. These conducting or semi-conducting layers, further, can suitably be made up of metal, sprayed on, or varnishes containing suspended metal particles, in which case the spraying on of the metal or application of the varnish takes place while the resin is still uncured, so that a close connection between the insulation and the said layers is obtained. The resin is then transformed to cured condition, preferably before the conducting or semi-conducting layers are embedded in the insulating covering. If the connection between the layers or with the earth should be broken e.g. by mechanical damage and corona arises, the furnace will not be incapable of function since the covering is capable of resisting the strain arising so that flashover does not occur. Consequently, it is possible under these circumstances to continue the process taking place under the planned conditions and thereby obtain the result aimed at with the treatment in the furnace. The furnace need not immediately afterwards be taken out of operation, but it may still be used in the normal way, so that repair of the corona protection screen may be made at a suitable time. Whether damage of such a nature that corona arises has occurred can further be established through the observable corona phenomenon on the covering, which makes it possible to stop the process under complete control, if it is considered suitable. This may be the case, for example, if certain parts of the furnace are made of materials which are easily damaged by corona, or if for special reasons it is suspected that the risk of flashover might be present with continued operation. Because a fault arising can be detected before flashover takes place, damages resulting from such a phenomenon consequently can be avoided.

The invention will now be described, by way of example, with reference to the accompanying drawing, in which:—

Figure 1 is a side view of a part of a helically wound, vacuum furnace water-cooled inductor coil in accordance with the invention, which is electrically insulated and provided with a corona protection screen; and

Figure 2 is a section of a turn of the coil of Figure 1 taken along the line A_1—A_2 of Figure 1.

The coil shown in the figures is only chosen as one example of a coil provided with a corona protection screen. In relation to the diameter of the coil, the conductor cross-sectional area is enlarged.

From Figure 1 is clear, partly the shape on the coil 1, a turn of which is seen in more detail in Figure 2, and partly how the conducting or semi-conducting layers, within the coil are insulated from each other and outside the coil are connected with each other by leads 2, and with earth. The conductor consists of a copper pipe 3 which is internally cooled by water. Outside the insulation 4, which consists for example of a silicone varnish, an epoxy resin, an alkyd varnish, a phenolic varnish, an unsaturated polyester resin, or silicone rubber, is applied a base layer 5 for conducting or semi-conducting layers 6, 7 and 8, which together with a covering 9 of a tight, pore-free and corona-resistant material, form the corona protection screen. An insulating material 10 is applied on the outside for protection against mechanical damage. The insulation 4 may also consist, e.g. of a wrapping of glass fibre tape impregnated with one or more of the above mentioned resins and varnishes or of a wrapping of silicone rubber tape reinforced with a glass fibre tape. The ground layer 5 consists in the exemplified case of a wrapping, e.g. with half-overlap, of a woven glass fibre tape, e.g. having a width of 19 mm and a thickness of 0.08 mm. After the glass tape has been applied to the insulation of the coil, an epoxy resin is applied, for example the epoxy resin known under the Trade Mark "Araldite XV" with "Curing Agent XV" from Ciba AG., which components are previously mixed in the proportion of 100 parts by weight of the first mentioned and 30 parts by weight of the last mentioned. The last mentioned epoxy resin is of the bisphenol type dissolved in a solvent, and the curing agent is of the anhydride type and is also dissolved in a solvent. Heating-curing as well as room-temperature-curing resin may be used. Instead of the exemplified epoxy resin other heat resistant thermosetting resins may be used such as other commercially axailable epoxy resin, silicone resin, or saturated or unsaturated polyester or phenolic resin. After solvents in the mixture have evaporated, but before the resin is cured, the conducting layers 6, 7 and 8 are applied, which layers may consist of lead and be applied by flame spray. They could also be constituted, for example, by varnishes containing suspended metals such as aluminium and silver in powder form. Each metal layer 6, 7, 8 encloses in this example, as is clear from Figure 2, 3/4 coil turns and is insulated from the metal layers 6 and 8 in the adjacent 3/4 coil turns by insulations 11 and 12 of the same type as the insulation 4. The metal layers are connected to each other outside the coil. From Figure 2 is seen particularly how the metal layers 6 and

7 are connected with each other via the connections 13 and 14 and the leads 2. The covering 9 may advantageously consist of a non-reinforced silicone rubber tape or of a silicone rubber tape containing a reinforced glass tape, for example of Westinghouse "Silastic" Tape 9495—12 having a width of 19 mm and a thickness of 0.25 mm from Westinghouse Corp. The silicone rubber tape may, for example, be wound in two layers with half-overlap. The winding must be done with the greatest care so that each part is covered by at least one tape thickness, and the bandage obtained is completely tight and pore-free. The outer protection 10, the main purpose of which is to protect the insulated coil, provided with the corona protection screen, from mechanical damage which may arise during transport, manipulation and mounting of the coil, may for example consist of glass tape with an adhesive material, or a silicone rubber tape reinforced with a woven glass fibre tape such as Tape No. 659 from Vernon Chemical and Mfg. Corp., having a width of 19 mm and a thickness of 0.15 mm. This tape may, e.g. be applied with half-overlap. If the covering 9 itself has sufficient resistance against mechanical damage, the protection 10 may be dispensed with. The resin used for attaching the metal layers to the insulation of the coil is suitably cured after the layers have been sprayed on, but curing may also be referred until the layers are covered with the tight and pore-free material.

WHAT WE CLAIM IS:—

1. A vacuum furnace inductor coil comprising an electrical conductor, a coating of electrical insulation applied around said conductor, a corona protection screen applied on said insulation and comprising electrically conducting or semi-conducting layers displaced with respect to one another in the longitudinal direction of the conductor and insulated from each other and a tight and pore-free covering of an electrically insulating material enclosing said electrically conducting or semi-conducting layers.

2. A vacuum furnace inductor coil as claimed in Claim 1, in which, said tight and pore-free covering of a wrapping of silicone rubber.

3. A vacuum furnace inductor coil as claimed in Claims 1 and 2, in which said corona protection screen is attached to said insulation of the conductor with a thermosetting resin.

4. A vacuum furnace inductor coil as claimed in Claims 1 to 3, in which said conducting or semi-conducting layers consist of layers of metal or of a varnish containing metal powder.

5. A process for the application of a corona protection screen on the insulation of the conductor of an inductor coil for a vacuum furnace, comprising applying a thermosetting resin on said insulation, whereafter, while said resin is still uncured, layers of conducting or semi-conducting material displaced with respect to one another in the longitudinal direction of the conductor are applied to the resin, whereupon said layers of conducting or semi-conducting material are covered with a tight and pore-free covering of an insulating material preferably after said resin has been transformed to cured condition.

6. A process as claimed in Claim 5, in which said tight and pore-free covering consists of a wrapping of silicone rubber.

7. A vacuum furnace inductor coil constructed and arranged substantially as hereinbefore described, with reference to, and as illustrated, in the accompanying drawing.

8. A vacuum furnace comprising the inductor coil claimed in any one of Claims 1, 2, 3, 4 or 7.

J. Y. & G. W. JOHNSON,
47, Loncoln's Inn Fields, London, W.C.2,
Chartered Patent Agents.

Leamington Spa: Printed for Her Majesty's Stationery Office by the Courier Press.—1962.
Published at The Patent Office, 25, Southampton Buildings, London, W.C.2, from which copies may be obtained.

913386 COMPLETE SPECIFICATION
1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

Fig.1

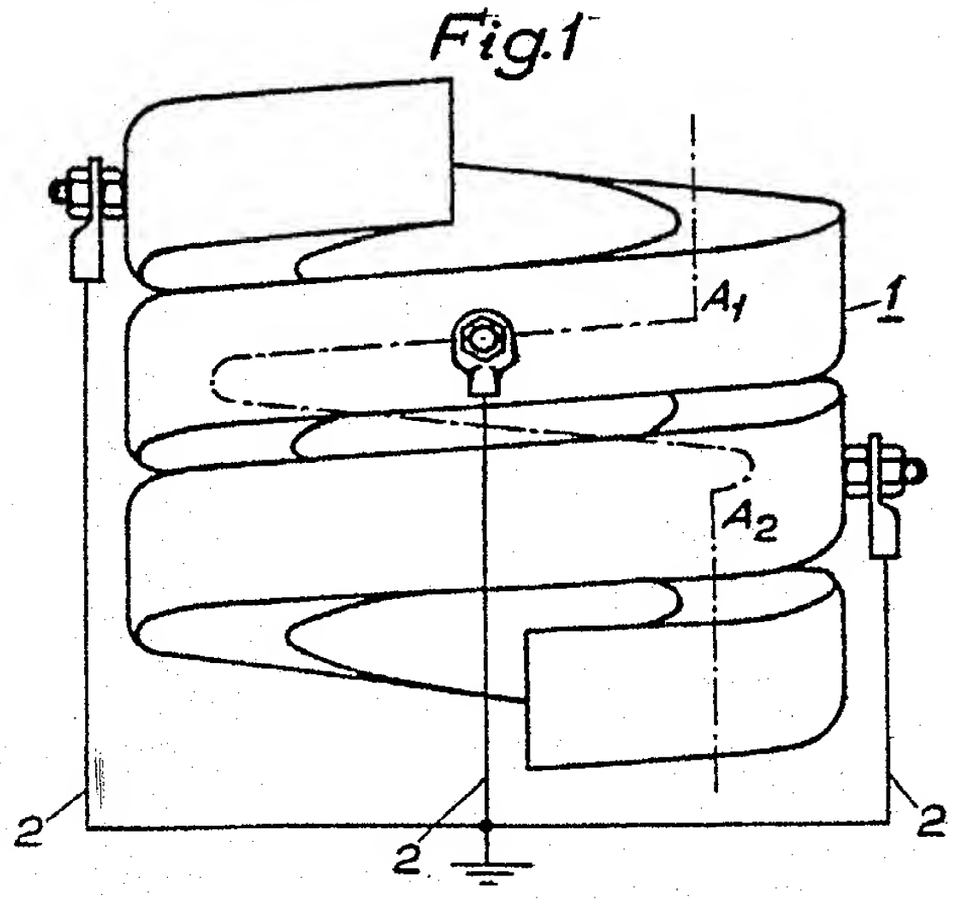

Fig.2